Hydraulic Capacity and Modeling Analysis Cardinal Creek Village South Development

Technical Memorandum

FINAL

Prepared for:
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Project: 2021-077-DSE

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	January 31, 2022	Draft	Ben Loewen	Werner de Schaetzen
R1	May 31, 2022	Updated Draft	Ben Loewen/Cole Dinsdale	Werner de Schaetzen
R2	June 16, 2022	Final	Ben Loewen/Cole Dinsdale	Werner de Schaetzen
R3	November 26, 2024	Draft	Jim Lee	Werner de Schaetzen
R4	November 29, 2024	Updated Draft	Jim Lee	Werner de Schaetzen
R5	December 2, 2024	Final	Jim Lee	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents GeoAdvice Engineering Inc. best professional judgment based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, express or implied is made.

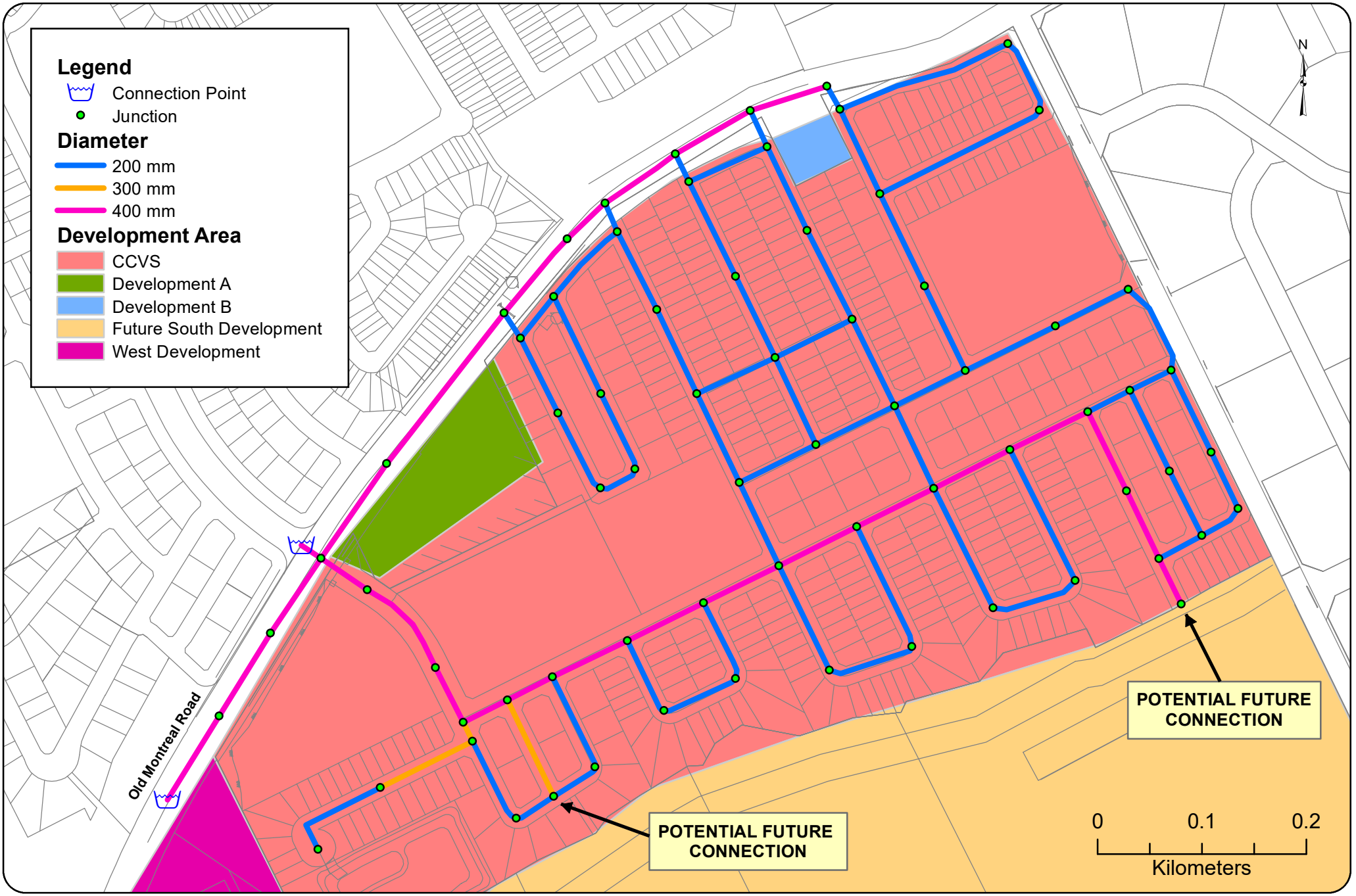
1 Introduction

GeoAdvice Engineering Inc. ("GeoAdvice") was retained by David Schaeffer Engineering Ltd. ("DSEL") to size the proposed water main network for the Cardinal Creek Village South (CCVS) development ("Development") in the City of Ottawa, ON ("City").

The development will have two (2) connections to the City's water distribution system along Old Montreal Road. The development site is shown in **Figure 1.1** on the following page, with the final recommended pipe diameters.

This memo describes the assumptions and results of the hydraulic modeling and capacity analysis using InfoWater (Innovyze), a GIS water distribution system modeling and management software application.

The results presented in this memo are based on the analysis of steady state simulations. The predicted available fire flows, as calculated by the hydraulic model, represent the flow available in the water main while maintaining a residual pressure of 20 psi at the hydrant. No extended period simulations were completed in this analysis to assess the water quality or to assess the hydraulic impact on storage and pumping.



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis**
Cardinal Creek Village South
Client: **David Schaeffer Engineering Ltd.**
Date: **November 2024**
Created by: **JL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

Site Layout and Connection Points

Figure 1.1

2 Modeling Considerations

2.1 Water Main Configuration

The water main network was modeled based on drawings prepared by DSEL (1153_grad_coord.dwg) and provided to GeoAdvice on October 30th, 2024.

2.2 Elevations

Elevations of the modeled junctions were assigned according to a preliminary site grading plan at road level, which was prepared by DSEL (1153_grad_coord.dwg) and provided to GeoAdvice on October 30th, 2024.

2.3 Consumer Demands

The proposed residential demands for the CCVS development were based on a demand rate of 280 L/cap/d as per City of Ottawa technical bulletin ISTB 2018-01. The park and school rate of 28,000 L/ha/d was assumed as per the City of Ottawa design guidelines and is consistent with similar previously completed developments within the City of Ottawa. Demand factors used for this analysis were taken according to the peaking factors based on population of 3,001-10,000 capita from the MOE Design Guidelines. Population densities were assigned based on Table 4.1 *Per Unit Populations* from the City of Ottawa Design Guidelines. Relevant data for this development is summarized in **Table 2.1**.

Furthermore, demands for the future development located to the south of the CCVS development were included to consider potential future connections and were based on the demand rates from the Cardinal Creek Village Master Servicing Study (Veritec report, April 2013), as provided by DSEL. Demands from three (3) additional adjacent development areas (Developments A, B, and West) were incorporated into the CCVS analysis due to their downstream location relative to the City's boundary conditions. These developments are shown in **Figure 1.1** and summarized in **Appendix A**.

Table 2.1: City of Ottawa and MOE Demand Factors

Demand Type	Amount	Units
Average Day Demand		
Residential	280	L/c/d
Park	28,000	L/ha/d
School	28,000	L/ha/d
Maximum Daily Demand		
Residential	2.0 x avg. day	L/c/d
Park	1.5 x avg. day	L/ha/d
School	1.5 x avg. day	L/ha/d
Peak Hour Demand		
Residential	3.0 x avg. day	L/c/d
Park	1.8 x max. day	L/ha/d
School	1.8 x max. day	L/ha/d
Minimum Hour Demand		
Residential	0.5 x avg. day	L/c/d
Park	0.5 x avg. day	L/ha/d
School	0.5 x avg. day	L/ha/d

Table 2.2 and **Table 2.3** summarize the water demand calculations for CCVS development.

Table 2.2: Development Population and Demand Calculations – CCVS Development ǂ

Dwelling Type	Number of Units	Persons Per Unit*	Population	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)
Single Detached	333	3.4	1,133	3.67	7.34	11.02
Back-to-Back Townhome	152	2.7	411	1.33	2.66	4.00
Traditional Townhome	261	2.7	705	2.28	4.57	6.85
Total	**746**		**2,249**	**7.29**	**14.58**	**21.87**

*City of Ottawa Design Guidelines.
ǂ Peaking factors based on development population of 3,001-10,000 capita from the MOE Design Guidelines.

Table 2.3: Non Residential Demand Calculations – CCVS Development ǂ

Land Use Type	Area (ha)	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)
Park	1.58	0.51	0.77	1.38
School	4.90	1.59	2.38	4.29
Commercial	2.40	0.78	1.17	2.10

ǂ Peaking factors based on the City of Ottawa Design Guidelines

Table 2.4 and **Table 2.5** summarize the water demand calculations for the future development adjacent to the CCVS development.

Table 2.4: Development Population and Demand Calculations – Additional Developments‡

Development	Population	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)
Future Development South of CCVS	3,683	8.26	12.73	27.47
Development A	73	0.24	0.47	0.71
Development B	28	0.09	0.18	0.27
West Development	991	3.21	6.42	9.63
Total	**4,775**	**11.80**	**19.80**	**38.08**

‡ Peaking factors based on the previous water main hydraulic analysis (Veritec report, April 2013)

Table 2.5: Non Residential Demand Calculations – Additional Developments‡

Land Use Type	Area (ha)	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)
Park	2.50	0.25	0.25	0.32
School	2.00	0.20	0.20	0.26
Commercial	1.49	0.48	0.72	1.30

‡ Peaking factors based on the previous water main hydraulic analysis (Veritec report, April 2013)

The demand rates used are for preliminary design purposes. It is recommended that the development network be modeled and sized according to the City's standards during the detailed design phase. Detailed demand calculations are provided in **Appendix A**.

2.4 Fire Flow Demand

Fire flow values were based on a previous report submitted by GeoAdvice on June 16, 2022. Fire flow simulations were completed at each model node under the required fire flow scenarios listed below. The locations of nodes do not necessarily represent hydrant locations.

Each building type was assigned the following required fire flows:

- 167 L/s (single-family and traditional townhouse units)
- 200 L/s (back-to-back townhouse units, accounting for one (1) firewall)
- 250 L/s (required fire flow of Area A, as confirmed by DSEL

Please note that the required fire flow for the school blocks and commercial area has been assumed as 150 L/s, as per the Master Municipal Construction Documents (MMCD). Where multiple fire flow conditions were present, the most conservative fire flow requirement was assigned.

The figure illustrating the spatial allocation of the required fire flows is provided in **Appendix B**.

2.5 Boundary Conditions

The boundary conditions were provided by the City of Ottawa in the form of Hydraulic Grade Line (HGL) at the following locations:

- Connection 1: Old Montreal Road
- Connection 2: Old Montreal Road at Cardinal Creek Drive

The connections are illustrated in **Figure 1.1**.

Boundary conditions were provided for Peak Hour (PHD), Maximum Day plus Fire (MDD+FF) and Average Day (high pressure check, ADD) demand conditions.

The City boundary conditions were provided to GeoAdvice on October 30, 2024 and can be found in **Appendix C**.

The demands from the future development south of the CCVS development and the additional Developments A, B and West were included in the boundary condition request as they are located downstream from the connection points used in the boundary conditions.

3 Hydraulic Capacity Design Criteria

3.1 Pipe Characteristics

Pipe characteristics of internal diameter (ID) and Hazen-Williams C factors were assigned in the model according to the City of Ottawa Design Guidelines for PVC water main material. Pipe characteristics used for the development are outlined in **Table 3.1** below.

Table 3.1: Model Pipe Characteristics

Nominal Diameter (mm)	ID PVC (mm)	Hazen Williams C-Factor (/)
200	204	110
300	297	120
400	400	120

3.2 Pressure Requirements

As outlined in the City of Ottawa Design Guidelines, the generally accepted best practice is to design new water distribution systems to operate between 350 kPa (50 psi) and 480 kPa (70 psi). The maximum pressure at any point in the distribution system in occupied areas outside of the public right-of-way shall not exceed 552 kPa (80 psi). Pressure requirements are outlined in **Table 3.2.**

Table 3.2: Pressure Requirements

Demand Condition	Minimum Pressure		Maximum Pressure	
	(kPa)	(psi)	(kPa)	(psi)
Normal Operating Pressure (maximum daily flow)	350	50	480	70
Peak Hour Demand (minimum allowable pressure)	276	40	-	-
Maximum Fixture Pressure (Ontario Building Code)	-	-	552	80
Maximum Distribution Pressure (minimum hour check)	-	-	552	80
Maximum Day Plus Fire	140	20	-	-

4 Hydraulic Capacity Analysis

The proposed water mains within the development were sized to the minimum diameter which would satisfy the greater of maximum day plus fire and peak hour demand. Modeling was carried out for average day demand (ADD), peak hour demand (PHD) and maximum day demand plus fire flow (MDD+FF) using InfoWater.

4.1 Development Pressure Analysis

Modeled service pressures for the proposed CCVS development are summarized in **Table 4.1** below. Figures showing the pressures under ADD and PHD scenarios are provided in **Appendix D**.

Table 4.1: Summary of Available Service Pressures

Average Day Demand Maximum Pressure	Peak Hour Demand Minimum Pressure
76 psi (524 kPa)	41 psi (282 kPa)

As outlined in the City of Ottawa Design Guidelines, the generally accepted best practice is to design new water distribution systems to operate between 350 kPa (50 psi) and 480 kPa (70 psi). The maximum pressure at any point within the distribution system in occupied areas outside of the public right-of-way shall not exceed 552 kPa (80 psi) and the minimum pressure at any point within the distribution system shall not fall below 270 kPa (40 psi). **The maximum service pressure is 76 psi, below the 80 psi threshold, therefore no PRVs are required for the proposed development. The minimum service pressure is 41 psi, meeting the required 40 psi threshold.**

4.2 Development Fire Flow Analysis

Table 4.2: Summary of the Minimum Available Fire Flows

Required Fire Flow	Minimum Available Flow*
167 L/s	170 L/s
200 L/s	201 L/s
250 L/s	>500 L/s

*The predicted available fire flows, as calculated by the hydraulic model, represent the flow available in the water main while maintaining a residual pressure of 20 psi at the hydrant. High available fire flows (>500 L/s) are theoretical values. Actual available fire flow is limited by the hydraulic losses through the hydrant lateral and hydrant port sizes.

As summarized in Table 4.2 the fire flow requirements can be met at all junctions within the development.

The figure showing the available fire flows at 20 psi under MDD + FF scenario can be found in **Appendix E**.

Submission

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Appendix A Domestic Water Demand Calculations and Allocation

Consumer Water Demands

Dwelling Type	Number of Units	Population		Average Day Demand			Max Day	Peak Hour
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)	2 x Avg. Day (L/s)	3 x Avg. Day (L/s)
Single Detached	32	3.4	109	280	30,520	0.35	0.71	1.06
Back-to-Back Townhome	40	2.7	108		30,240	0.35	0.70	1.05
Traditional Townhome	35	2.7	95		26,600	0.31	0.62	0.92
Subtotal	**107**		**312**		**87,360**	**1.01**	**2.02**	**3.03**

Non Residential Demands - CCV South Phase 1

Property Type	Area (ha)		Average Day Demand			Max Day	Peak Hour
			(L/ha/d)	(L/d)	(L/s)	1.5 x Avg. Day (L/s)	1.8 x Max Day (L/s)
Commercial	2.40		28,000	67,200	0.78	1.17	2.10
Subtotal	**2.40**			**67,200**	**0.78**	**1.17**	**2.10**

Residential Demands - CCV South Phase 2*

Dwelling Type	Number of Units	Population		Average Day Demand			Max Day	Peak Hour
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)	2 x Avg. Day (L/s)	3 x Avg. Day (L/s)
Single Detached	78	3.4	266	280	74,480	0.86	1.72	2.59
Back-to-Back Townhome	0	2.7	-		-	-	-	-
Traditional Townhome	54	2.7	146		40,880	0.47	0.95	1.42
Subtotal	**132**		**412**		**115,360**	**1.34**	**2.67**	**4.01**

Non Residential Demands - CCV South Phase 2

Property Type	Area (ha)		Average Day Demand			Max Day	Peak Hour
			(L/ha/d)	(L/d)	(L/s)	1.5 x Avg. Day (L/s)	1.8 x Max Day (L/s)
School (Block 59)	2.44		28,000	68,320	0.79	1.19	2.14
Subtotal	**2.44**			**68,320**	**0.79**	**1.19**	**2.14**

Residential Demands - CCV South Phase 3*

Dwelling Type	Number of Units	Population		Average Day Demand			Max Day	Peak Hour
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)	2 x Avg. Day (L/s)	3 x Avg. Day (L/s)
Single Detached	61	3.4	208	280	58,240	0.67	1.35	2.02
Back-to-Back Townhome	72	2.7	195		54,600	0.63	1.26	1.90
Traditional Townhome	62	2.7	168		47,040	0.54	1.09	1.63
Subtotal	**195**		**571**		**159,880**	**1.85**	**3.70**	**5.55**

Residential Demands - CCV South Phase 4*

Dwelling Type	Number of Units	Population		Average Day Demand			Max Day	Peak Hour
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)	2 x Avg. Day (L/s)	3 x Avg. Day (L/s)
Single Detached	39	3.4	133	280	37,240	0.43	0.86	1.29
Back-to-Back Townhome	40	2.7	108		30,240	0.35	0.70	1.05
Traditional Townhome	69	2.7	187		52,360	0.61	1.21	1.82
Subtotal	**148**		**428**		**119,840**	**1.39**	**2.77**	**4.16**

Non Residential Demands - CCV South Phase 4

Property Type	Area (ha)‡		Average Day Demand			Max Day	Peak Hour
			(L/ha/d)	(L/d)	(L/s)	1.5 x Avg. Day (L/s)	1.8 x Max Day (L/s)
Park (Block 58)	1.58		28,000	44,240	0.51	0.77	1.38
Subtotal	**1.58**			**44,240**	**0.51**	**0.77**	**1.38**

Residential Demands - CCV South Phase 5*

Dwelling Type	Number of Units	Population		Average Day Demand			Max Day	Peak Hour
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)	2 x Avg. Day (L/s)	3 x Avg. Day (L/s)
Single Detached	123	3.4	419	280	117,320	1.36	2.72	4.07
Back-to-Back Townhome	-	2.7	-		-	-	-	-
Traditional Townhome	41	2.7	111		31,080	0.36	0.72	1.08
Subtotal	**164**		**530**		**148,400**	**1.72**	**3.44**	**5.15**

Non Residential Demands - CCV South Phase 5

Property Type	Area (ha)		Average Day Demand (L/ha/d)	Average Day Demand (L/d)	Average Day Demand (L/s)	Max Day 1.5 x Avg. Day (L/s)	Peak Hour 1.8 x Max Day (L/s)
School (Block 34)	2.464		28,000	68,992	0.80	1.20	2.16
Subtotal	**2.464**			**68,992**	**0.80**	**1.20**	**2.16**

Residential Demands - Area A *

Dwelling Type	Number of Units	Population Persons per Unit	Population Population Per Dwelling Type	Average Day Demand (L/c/d)	Average Day Demand (L/d)	Average Day Demand (L/s)	Max Day 2 x Avg. Day (L/s)	Peak Hour 3 x Avg. Day (L/s)
Multi-Family Residential (area 0.53 ha) ǂ	27	2.7	73	280	20,412	0.24	0.47	0.71
Subtotal	**27**		**73**		**20,412**	**0.24**	**0.47**	**0.71**

Non Residential Demands - Area A

Property Type	Area (ha)		Average Day Demand (L/ha/d)	Average Day Demand (L/d)	Average Day Demand (L/s)	Max Day 1.5 x Avg. Day (L/s)	Peak Hour 1.8 x Max Day (L/s)
Commercial ǂ	1.49		28,000	41,720	0.48	0.72	1.30
Subtotal	**1.49**			**41,720**	**0.48**	**0.72**	**1.30**

Residential Demands - Area B*

Dwelling Type	Number of Units	Population Persons per Unit	Population Population Per Dwelling Typeǂ	Average Day Demand (L/c/d)	Average Day Demand (L/d)	Average Day Demand (L/s)	Max Day 2 x Avg. Day (L/s)	Peak Hour 3 x Avg. Day (L/s)
Single Family Residential (area 0.43 ha) ǂ	-	-	28	280	7,840	0.09	0.18	0.27
Subtotal	**-**		**28**		**7,840**	**0.09**	**0.18**	**0.27**

Residential Demands - Development west of CCV South*

Dwelling Type	Number of Units	Population Persons per Unit	Population Population Per Dwelling Typeǂ	Average Day Demand (L/c/d)	Average Day Demand (L/d)	Average Day Demand (L/s)	Max Day 2 x Avg. Day (L/s)	Peak Hour 3 x Avg. Day (L/s)
Multi-Family Residentialǂ	-	-	991	280	277,480	3.21	6.42	9.63
Subtotal	**-**		**991**		**277,480**	**3.21**	**6.42**	**9.63**

Residential Demands - Future Development south of CCV Southǂ

Dwelling Type	Number of Units	Population Persons per Unit	Population Population Per Dwelling Type	Average Day Demandǂǂ (L/unit/d)	Average Day Demandǂǂ (L/d)	Average Day Demandǂǂ (L/s)	Max Day (L/s)ǂǂ	Peak Hour (L/s)ǂǂ
Single Detached	368	3.4	1,252	570	209,760	2.43	6.90	18.13
Back-to-Back Townhome	245	2.7	662	560	137,200	1.59	1.59	2.54
Traditional Townhome	655	2.7	1,769	560	366,800	4.25	4.25	6.79
Subtotal	**1,268**		**3,683**		**713,760**	**8.26**	**12.73**	**27.47**

Non Residential Demands - Future Development south of CCV Southǂ

Property Type	Area (ha)		Average Day Demandǂǂ (L/ha/d)	Average Day Demandǂǂ (L/d)	Average Day Demandǂǂ (L/s)	Max Day (L/s)ǂǂ	Peak Hour (L/s)ǂǂ
School	2.00		8,500	17,000	0.20	0.20	0.26
Park	2.50		8,500	21,250	0.25	0.25	0.32
Subtotal	**4.50**			**38,250**	**0.44**	**0.44**	**0.58**

		Avg. Day	**Max Day**	**Peak Hour**
Total (Connection Points 1 & 2)		**22.39**	**39.13**	**68.26**

*Peaking factors based on development population of 3,001-10,000 capita from the MOE Design Guidelines

ǂProvided by DSEL

ǂǂPeaking factors from the previous Cardinal Creek Village Study (Veritec, 2013)

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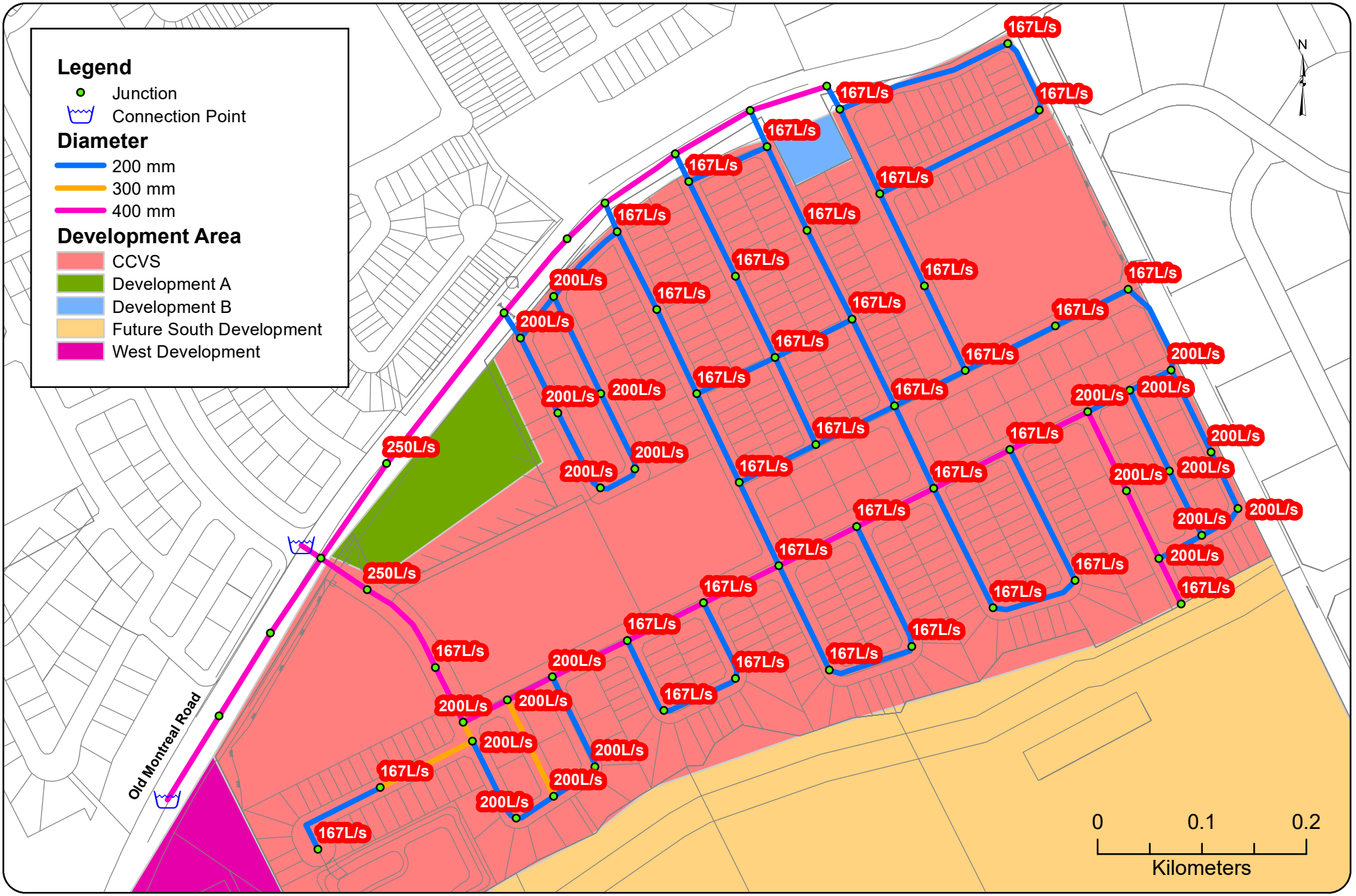
Appendix B Required Fire Flow Allocation



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Required Fire Flow

Figure B.1

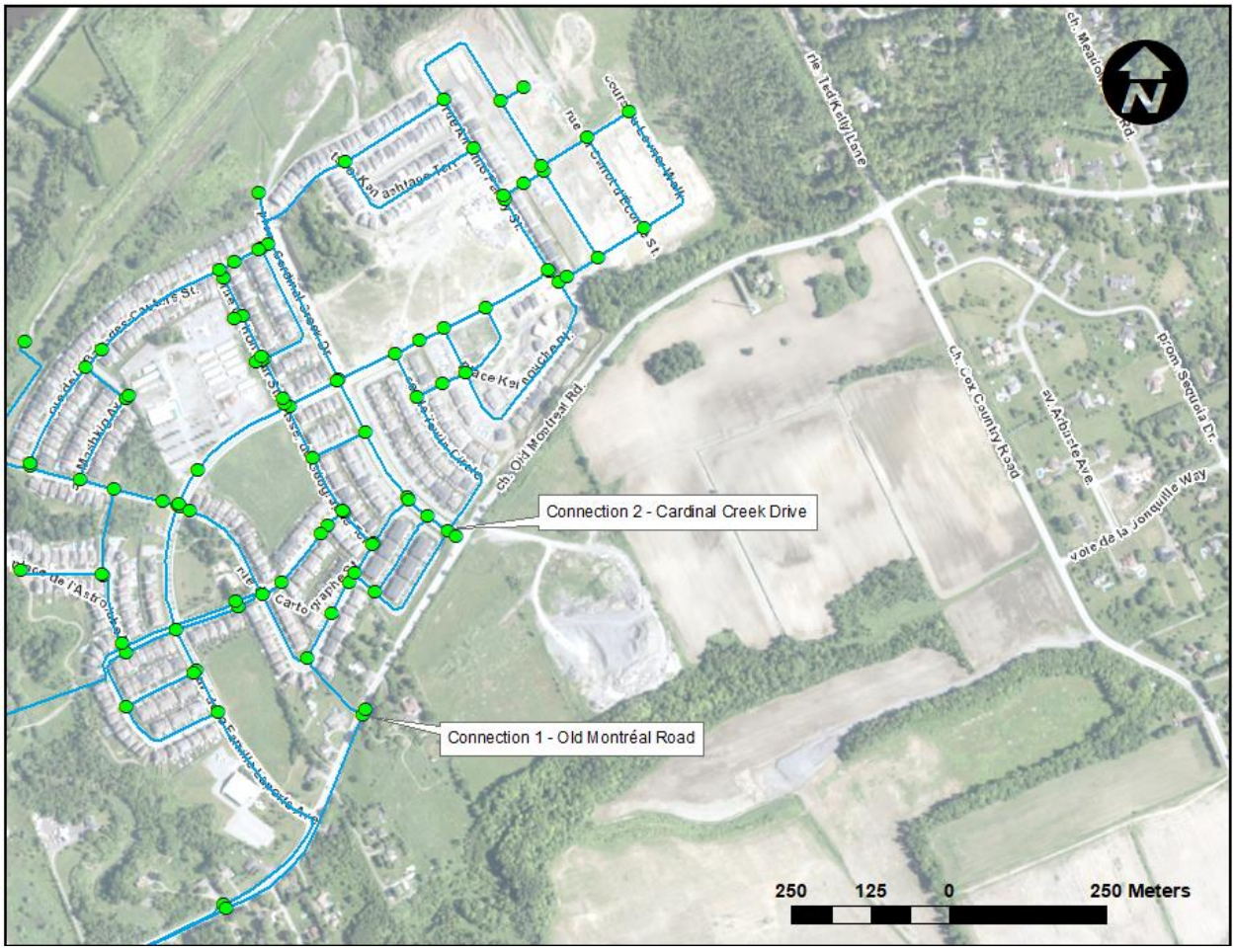
Appendix C Boundary Conditions

Boundary Conditions
Cardinal Creek Village South – E4 & E5 UEA

Provided Information

Scenario	Demand	
	L/min	L/s
Average Daily Demand	1,343	22.39
Maximum Daily Demand	2,348	39.13
Peak Hour	4,096	68.26
Fire Flow Demand #1	10,000	166.67
Fire Flow Demand #2	15,000	250.00

Location



Results

Connection 1 – Old Montréal Road

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	130.2	80.6
Peak Hour	124.9	73.1
Max Day plus Fire Flow #1	123.6	71.2
Max Day plus Fire Flow #2	119.8	65.8

Ground Elevation = 73.5 m

Connection 2 – Cardinal Creek Drive

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	130.1	76.5
Peak Hour	124.7	68.8
Max Day plus Fire Flow #1	121.3	63.9
Max Day plus Fire Flow #2	115.2	55.2

Ground Elevation = 76.3 m

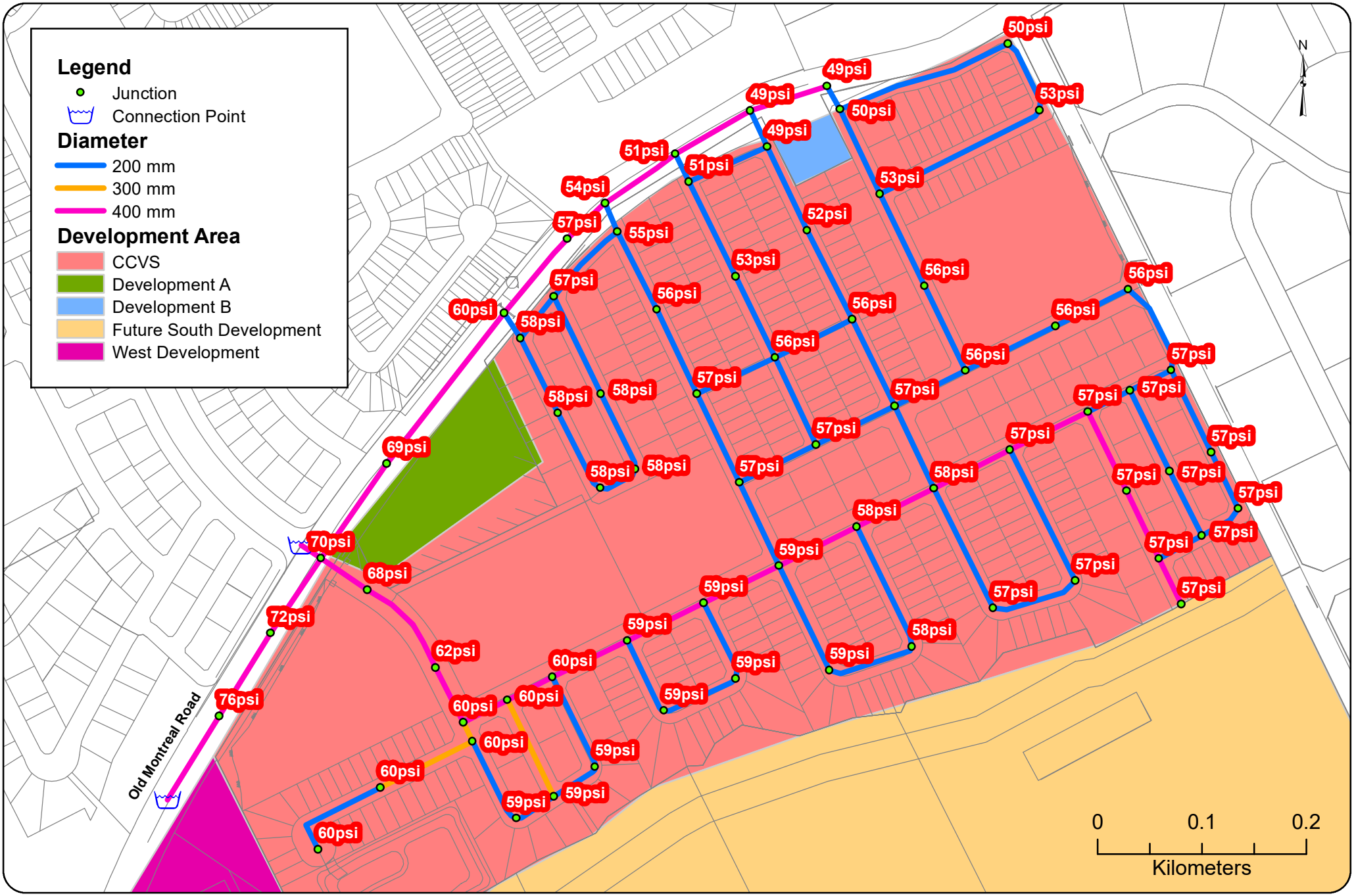
Notes

1. As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:
    a. If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
    b. Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.
2. No additional pumps turned on during different scenarios.

Disclaimer

The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

Appendix D ADD and PHD Pressures



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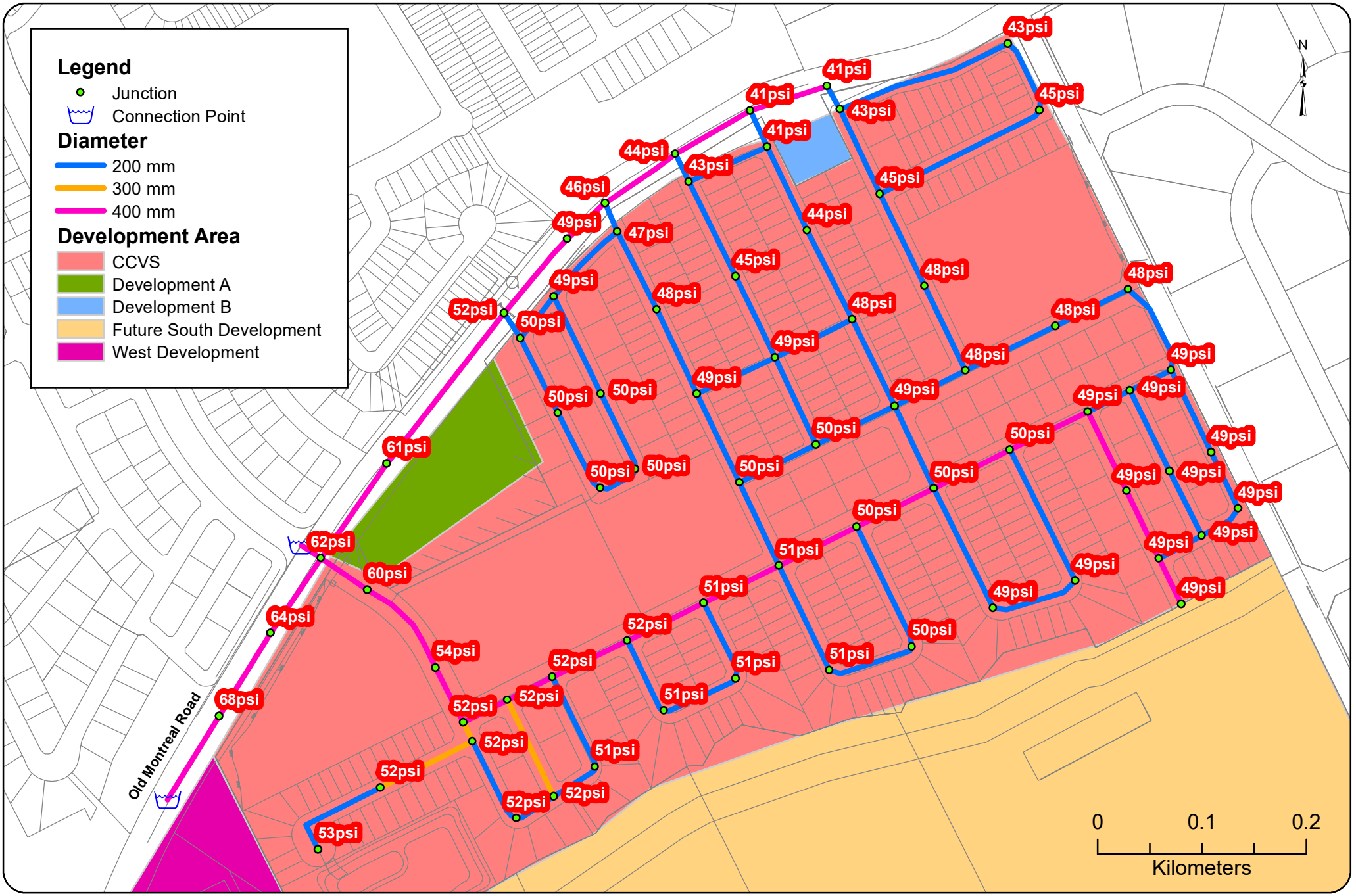
ADD Pressure Results

Figure D.1



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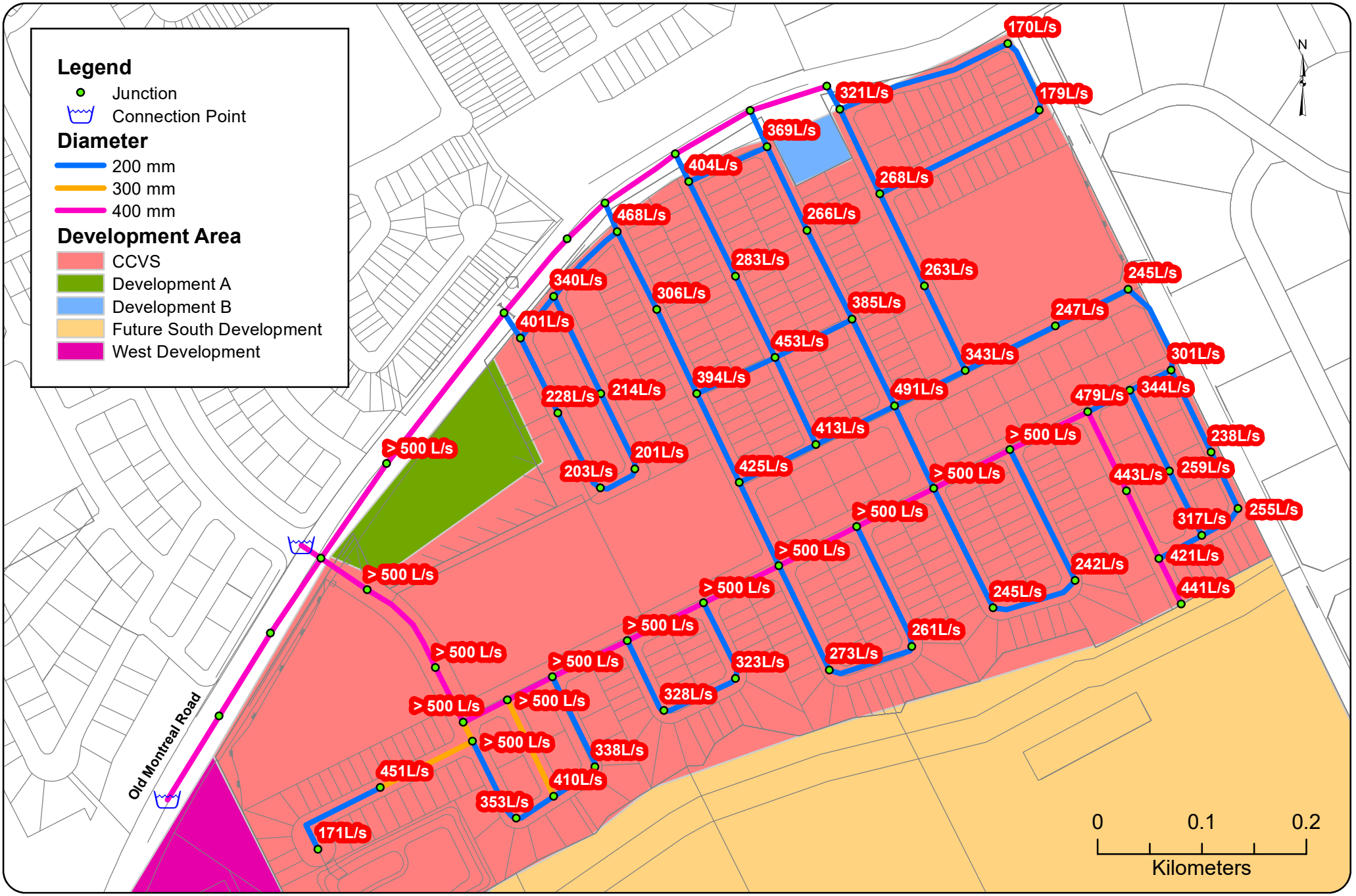
PHD Pressure Results

Figure D.2

Appendix E MDD+FF Model Results



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis**
Cardinal Creek Village South
Client: **David Schaeffer Engineering Ltd.**
Date: **November 2024**
Created by: **JL**
Reviewed by: **WdS**

Available Fire Flow @ 20 psi MDD + FF Scenario

Figure E.1